DOCUMENT RESUME

ED 154 015 95 TM 007 023

AUTHOR DiLuzio, Geneva J.; And Others
TITLE Technical Manual for the Conceptual Learning and Development Assessment Series IV: Tree. Technical Report No. 437. Reprinted December 1977.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO WRDCCL-TR-437
PUB DATE Dec 75
CONTRACT NE-C-00-3-0065
NOTE 66p.; For related documents, see ED 103 485 and TM 007 022

EDRS PRICE MF-$0.83 HC-$3.50 Plus Postage.
DESCRIPTORS Abstraction Levels; Cognitive Development; Cognitive Measurement; Cognitive Processes; *Cognitive Tests; Complexity Level; *Concept Formation; Developmental Stages; Elementary Secondary Education; *Fundamental Concepts; Learning Theories; Measurement Goals; Standardized Tests; *Statistical Data; *Test Construction; Test Items; Test Reliability; Trees
IDENTIFIERS *Model of Conceptual Learning and Development; *Test Manuals

ABSTRACT

This document accompanies the Conceptual Learning and Development Assessment Series III: Tree, a test constructed to chart the conceptual development of individuals. As a technical manual, it contains information on the rationale, development, standardization, and reliability of the test, as well as essential information and statistical data for evaluating the test. This report is designed to be used by individuals who have a general knowledge of test construction and measurement principles and are aware of the limitations of test interpretations. The authors of this manual have attempted to take into account and satisfy the standards set forth by the American Psychological Association regarding educational and psychological tests. The test is based upon the Conceptual Learning and Development (CLD) Model, which suggests four successive levels of concept learning: (1) concrete--recognizing an object which has been encountered previously; (2) identity--recognizing a known object when it appears in a different spatial, time, or sensory perspective; (3) classificatory--generalizing that two items are alike in some way; and (4) formal--naming and defining the concept, listing its attributes, and judging the presence of such attributes in an object. (Author/GDC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

TM

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Regents, Univ. of Wisconsin

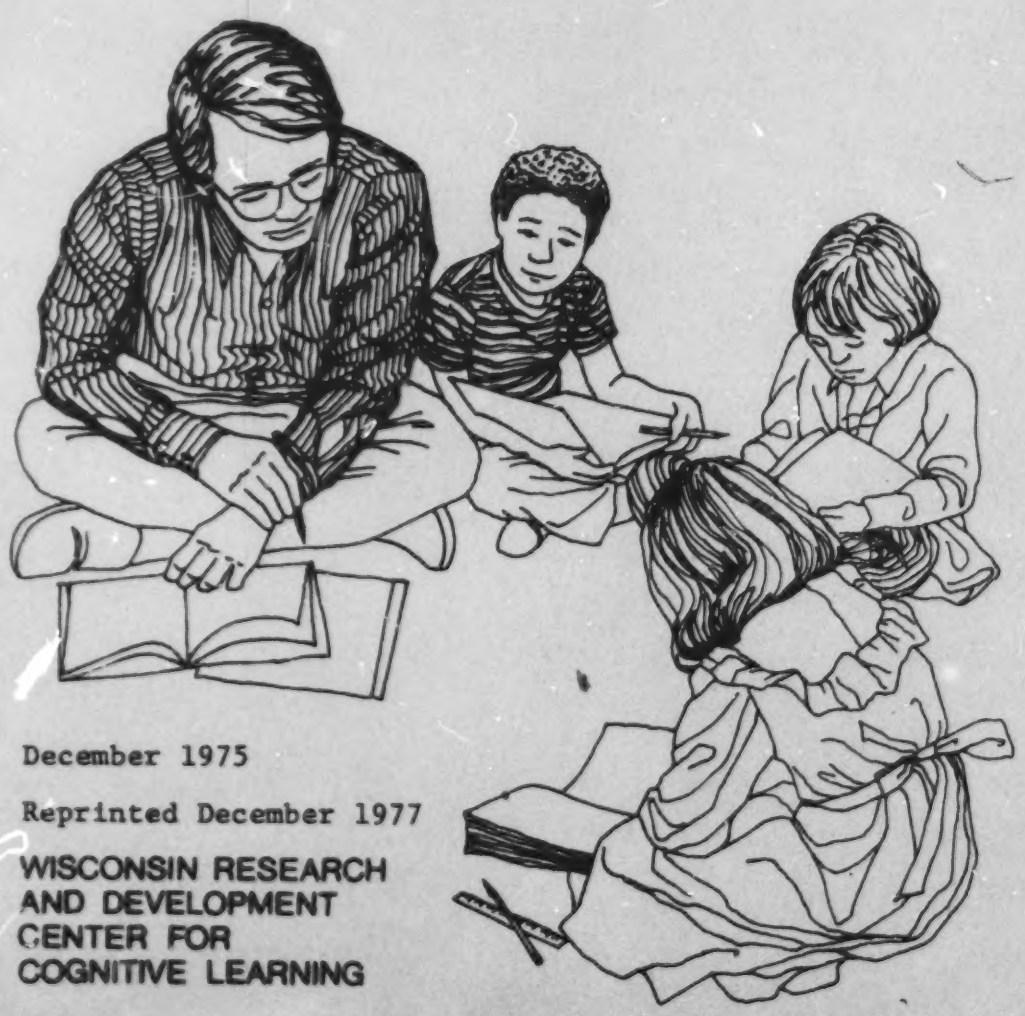
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

ED154015

Technical Report No. 437

TECHNICAL MANUAL FOR THE CONCEPTUAL LEARNING AND DEVELOPMENT ASSESSMENT SERIES IV: TREE

by Geneva J. DiLuzio, Conrad G. Katzenmeyer, and Herbert J. Klausmeier



December 1975

Reprinted December 1977

WISCONSIN RESEARCH AND DEVELOPMENT CENTER FOR COGNITIVE LEARNING

TM007 023

Technical Report No. 437

TECHNICAL MANUAL FOR THE CONCEPTUAL LEARNING AND DEVELOPMENT ASSESSMENT SERIES IV: TREE

by

Geneva J. DiLuzio, Conrad G. Katzenmeyer,
and Herbert J. Klausmeier

Report from the
Technical Services Section

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

December 1975

Reprinted December 1977

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the National Institute of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education and no official endorsement by that agency should be inferred.

Center Contract No. NE-C-00-3-0065

MISSION STATEMENT

The mission of the Wisconsin Research and Development Center is to improve the quality of education by addressing the full range of issues and problems related to individualized schooling. Teaching, learning, and the problems of individualization are given concurrent attention in the Center's efforts to discover processes and develop strategies and materials for use in the schools. The Center pursues its mission by

- conducting and synthesizing research to clarify the processes of school-age children's learning and development
- conducting and synthesizing research to clarify effective approaches to teaching students basic skills and concepts
- developing and demonstrating improved instructional strategies, processes, and materials for students, teachers, and school administrators
- providing assistance to educators which helps transfer the outcomes of research and development to improved practice in local schools and teacher education institutions

The Wisconsin Research and Development Center is supported with funds from the National Institute of Education and the University of Wisconsin.

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR COGNITIVE LEARNING

ACKNOWLEDGMENTS

The writing of a technical manual to accompany a test requires the combined efforts of many people. Our first order of business is to thank Mr. Keith White, project specialist, for his efforts in collecting the data from which the test characteristics were computed. We also appreciate the efforts of Mr. Tom Sipple and Dr. Patricia Allen for providing detailed information about the test batteries. A special note of thanks goes to Mr. Edward Haertel, technical specialist, who performed the yeoman's work by analyzing the data.

Finally, a sincere thank you to Ms. Cathy Halverson and Ms. Julie Pohlkamp who so carefully typed our first draft.

TABLE OF CONTENTS

	Page
Acknowledgments	iv
List of Tables	vii
Abstract	ix
I. Rationale of the Test.	1
Overview of the Conceptual Learning and Development Model (CLD): The Bases for Test Development.	1
General Characteristics of the CLD Model	1
Definition of Concepts	2
Structure of the Model	2
Levels of Concept Attainment.	2
Concept Utilization and Extension	3
Other Characteristics of the Model	4
Description of the Conceptual Learning and Development Assessment Series IV: Tree.	
Scope of the Test Battery.	5
Concrete Level Subtest	5
Identity Level Subtest	9
Classificatory Level Subtest	9
Formal Level Subtests.	11
Evaluating and Defining Subtest	11
Naming Subtest.	14
Discriminating Attributes Subtest	15
Supraordinate-Subordinate Relations Subtest.	15
Principles Subtest	16
Problem-Solving Subtest.	16
Additional Information for the Concept Tree	19
Development of the Conceptual Learning and Development Assessment Series IV: Tree.	20
Guidelines Used in Test Development.	20
Writing Items.	21
Review of Test Battery Content by Specialists.	21
Tryout of Items.	22
Development of Final Edition	22
Production of Final Test Materials.	22
Writing of Test Administration Manuals.	23
Computerized Analyses of Test Results	23
Summary.	24

TABLE OF CONTENTS (cont.)

Chapter		Page
	Changes to the Preliminary Edition	24
	Production of Final Test Materials	24
	Writing Test Administration Manuals	25
	Computerized Analyses of Test Results	26
	Summary	26
II.	Standardization	27
	Description of the Standardization Sample	27
	Administration of the Test to the Standardization Sample	29
	Means and Standard Deviations from the Standardization Sample	29
III.	Statistical Properties	33
	Reliability	33
	Item Difficulties (Percent of Correct Response)	34
	Intercorrelation of the Total Levels Score with the Total Uses Score	
	Patterns of Concept Attainment	38
	References	45
	Appendices	
	A--Descriptive Scale Statistics for the Cutting Tool Battery	47
	B--Descriptive Item Statistics for the Cutting Tool Battery	53

LIST OF TABLES

Table		Page
1	Appropriateness, Average Administration Time, and Item Content of the Various Subtests of the Conceptual Learning and Development Assessment Series IV: Tree for Children in Different Grade Groups in the Standardization Sample	6
2	Description of Plants Employed in the Concrete Level Subtest.	8
3	Description of Plants Employed in the Identity Level Subtest, and Their Approximate Degree of Rotation.	10
4	Attributes of Plants Employed in the Classificatory Level Subtest.	12
5	Defining Attributes Being Tested by Each of the First Ten Items of the Evaluating and Defining Subtest	13
6	Names of Attributes Tested by Each Item of the Naming Subtest	14
7	Defining Attributes Being Tested by Each Item of the Discriminating Attributes Subtest.	15
8	Relations Tested and Classes of Plants Employed in the Supraordinate-Subordinate Relations Subtest.	17
9	Principles Assessed and Use of Illustrations in the Principles and Problem-Solving Subtests.	18
10	Total Number of Children, Mean Age, and Age Range at Each Grade Group in the Standardization Sample	26
11	Means and Standard Deviations of Raw Scores on Each Subtest and on a Combined Formal Score, Total Levels Score, and Total Uses Score, by Grade Group for the Standardization Sample	28
12	Hoyt Reliability Coefficients and Standard Errors of Measurement on Each Subtest and on a Combined Formal Score, Total Levels Score, and Total Uses Score, by Grade Group and Across the Four Groups for the Standardization Sample	31

LIST OF TABLES (cont.)

Table		Page
13	Intercorrelation of the Total Levels Score and the Total Uses Score, By Grade Group and Across Grade Groups for the Standardization Sample	34
14	Number of Items and Criteria Defining Full Attainment for Each Concept Level.	35
15	Number and Proportion of Each Grade Group that Fully Mastered Each Level of Attainment	38
16	Number and Proportion of Four Grade Groups Conforming and Not Conforming to Predicted Sequence of Attainment. .	39
A-1	Means and Standard Deviations of Raw Scores on Each Subtest and on a Combined Formal Score, Total Levels Score, and Total Uses Score, by Grade Group, for Boys in the Standardization Sample	44
A-2	Means and Standard Deviations of Raw Scores on Each Subtest and on a Combined Foraml Score, Total Levels Score, and Total Uses Score, by Grade Group, for Girls in the Standardization Sample	46
B-1	Difficulties of Each Item in the Total Levels Score by Grade Group, and Difficulties and Point Biserial Correlations for the Same Items Combining Grade Groups for the Standardization Sample.	50
B-2	Difficulties of Each Item in the Total Uses Score by Grade Group, and Difficulties and Point Biserial Correlations for the Same Items Combining Grade Groups for the Standardization Sample.	53

ABSTRACT

This technical manual is one of three related publications to be used with the Conceptual Learning and Development Assessment Series III: Noun, a test constructed to chart the conceptual development of individuals. As a technical manual, it contains information on the rationale, development, standardization, and reliability of the test, as well as essential information and statistical data for evaluating the test.

This report is designed to be used by individuals who have a general knowledge of test construction and measurement principles and are aware of the limitations of test interpretations. The authors of this manual have attempted to take into account and satisfy the standards set forth by the American Psychological Association regarding educational and psychological tests.

An overview of the theoretical framework on which the test is based, a copy of the preliminary edition of the test battery, and directions for administration can be found in the Technical Report, Development of Conceptual Learning and Development Assessment Series III: Noun (Klausmeier, Ingison, Sipple, & Katzenmeyer, 1973. Reprinted December 1977.)

The most complete source of information regarding the theoretical framework on which the test is based is in Conceptual Learning and Development: A Cognitive View (Klausmeier, Ghatala, & Frayer, 1974).

I

RATIONALE OF THE TEST

OVERVIEW OF THE CONCEPTUAL LEARNING AND DEVELOPMENT MODEL (CLD): THE BASES FOR TEST DEVELOPMENT

This technical manual provides information on the rationale, development, and statistical properties of the Conceptual Learning and Development Assessment Series IV: Tree. The test battery is based upon the model of conceptual learning and development (CLD model) proposed by Klausmeier (1971) and more fully described by Klausmeier, Ghatala, and Frayer (1974). The CLD model is the theoretical framework which provides the basis for determining children's level of attainment and use of a particular concept.

The Conceptual Learning and Development Series IV: Tree was developed in the course of research on the CLD model for use in typical school settings. By providing the researcher with a measure of conceptual attainment, it permits the study of the relationships of level of conceptual attainment, concept usage, internal conditions of concept learning, and instructional conditions (Klausmeier, Ghatala, & Frayer, 1974). The instrument is unique in that it provides a standardized measure of the level of attainment of the concept tree and the uses of that concept, and it can be group administered.

General Characteristics of the CLD Model

The general characteristics of the CLD model are summarized by Klausmeier, Marliave, Katzenmeyer, and Siple (1974): It is an analytical, descriptive model. It defines four successive levels of concept attainment and three types of concept usage. It specifies cognitive operations which are involved in learning concepts at each of the four levels. It relates internal and external conditions of learning to the specified levels.

Definition of Concepts

Klausmeier, Ghatala, and Frayer (1974) use the word concept to designate mental constructs of individuals as well as identifiable public entities which are part of the substance of various disciples. Klausmeier, Davis, Ramsay, Fredrick, and Davies (1965) developed a definition of concept as an entity having a set of defining attributes, which is characteristic of concepts from a variety of disciplines. In addition, Klausmeier, Ghatala, and Frayer (1974) specified that most public concepts have eight attributes: learnability, usability, validity, generality, power, structure, instance numerousness, and instance perceptibility. Systematic analysis of a particular concept with regard to its various attributes is the method used to delineate the particular concept to be assessed by the battery and determine the format of the items used.

Structure of the Model

Levels of Concept Attainment. Four successive levels of concept attainment are specified by the model: concrete level, identity level, classificatory level, and formal level. Klausmeier, Marliave, Katzenmeyer, and Sipple (1974) describe the levels of attainment as follows:

> Attainment of a concept at the concrete level is inferred when the individual cognizes an object that he has experienced on a prior occasion. At this level, the object is experienced in exactly the same way on the second and later occasions. Attainment of a concept at the identity level is inferred when the individual cognizes an object as the same one previously encountered when observed from a different spatio-temporal perspective or sensed in a different modality. The attainment of a concept at the classificatory level is inferred when the individual treats at least two instances of the same set of things as equivalent. At this level the individual may be unable to name the attributes that are common to the instances. Attainment of a concept at the formal level is inferred when the individual can name the concept, discriminate and name the

> societally accepted defining attributes and values, and accurately evaluate instances as belonging or not belonging to the set in terms of the presence or absence of the defining attributes [p.7].

The normative pattern postulated for individuals who are attaining a concept is to move successively from each level to the next higher level given the following conditions: First, the concept is of the kind for which there are either actual instances or representations of instances observable in the environment; and second, the individual has had experience with the instances beginning in early childhood (Klausmeier, Ghatala, & Frayer, 1974). It is acknowledged that some concepts are not attained at all four of the successive levels. This can occur either because of the nature of the concepts or because the learning experiences of the individual do not permit their acquisition.

Concept Utilization and Extension. Once a concept is attained at the classificatory or formal levels it may be used in four ways. The first use is an example of horizontal transfer, in which the individual can use the attained concept in recognizing newly encountered examples and nonexamples. The three other uses, cognizing supraordinate-subordinate relations, cognizing various other relations among concepts, and generalizing to problem-solving situations, are examples of vertical transfer, in which individuals extend their knowledge about an attained concept by using it. It is not implied that attainment of the concepts at the classificatory level or formal level will be followed by mastery of all the uses.

In cognizing supraordinate-subordinate relations, individuals can, after verbal instruction, place instances of hierarchically related concepts into proper groups and can justify their decisions based on

the defining attributes of the group. At higher levels individuals are able to understand relationships described as the "whole is the sum of the parts" and "some but not all (Kofsky, 1966)." Understanding supraordinate-subordinate relationships increases the validity and usability of the individual's concepts (Klausmeier, Ghatala, & Frayer, 1974).

There are other statements of relations between or among concepts which involve causality, correlation, probability, or other valid relations. Being able to understand and use a valid relationship depends on knowledge of the concepts that are to be related. These types of relationships are different from relations among supraordinate and subordinate concepts (Klausmeier, Ghatala, & Frayer, 1974).

Problem solving is inferred in any situation where information about a concept or concepts is called into play and generalized to arrive at a solution to a particular problem. One example of concepts being used in problem solving is the application of familiar principles to new situations.

Other Characteristics of the Model

Information concerning the cognitive operations employed at each level of conceptual attainment and the internal and external conditions of learning necessary to concept attainment is presented in Conceptual Learning and Development: A Cognitive View (Klausmeier, Ghatala, & Frayer, 1974).

DESCRIPTION OF THE CONCEPTUAL LEARNING AND DEVELOPMENT ASSESSMENT SERIES IV: TREE

Scope of the Test Battery

There are six subtests used to assess the level of conceptual attainment: concrete level, identity level, classificatory level, evaluating and defining, naming, and discriminating attributes. The last three of these subtests are used to assess attainment of the formal level. Three additional subtests are used to assess concept usage: supraordinate-subordinate relations, principles, and problem solving.

This battery may be used with children of ages 4-18. It was standardized on children at four grade levels: 1, 4, 7, and 10. The span of age represented in the standardization sample provides sufficient information to examine the usability of each subtest for children of various ages. Two forms of the test were developed, primary and intermediate. Items used in the primary form are a subset of those used in the intermediate form. In addition, a simplified set of directions is used with the primary form.

In the process of test development, certain subtests were found to be too difficult or too easy for children in some grades. Table 1 presents the set of subtests found to be most appropriate for administration at each of the four grade levels included in the standardization sample, as well as the number of items per subtest and average amount of time needed to administer each subtest for each form.

Concrete Level Subtest

This eight-item subtest is designed to assess whether a child has attained the concept tree at the concrete level. A drawing of a tree is

TABLE 1

APPROPRIATENESS, AVERAGE ADMINISTRATION TIME, AND ITEM CONTENT OF THE VARIOUS SUBTESTS OF THE CONCEPTUAL LEARNING AND DEVELOPMENT ASSESSMENT SERIES IV: TREE FOR CHILDREN IN DIFFERENT GRADE GROUPS IN THE STANDARDIZATION SAMPLE

Subtest	Number of items				Average administration time in minutes			
	Primary form	Intermediate form			Primary form	Intermediate form		
	Grade 1	Grade 4	Grade 7	Grade 10	Grade 1	Grade 4	Grade 7	Grade 10
Concrete Level	8	NA	NA	NA	5	NA	NA	NA
Identity Level	8	NA	NA	NA				
Classificatory Level	8	8	8	8	5	5	5	5
Evaluating and Defining	10	11	11	11	12	10	10	10
Naming	11	14	14	14	10	10	10	10
Discriminating Attributes	10	10	10	10	5	5	5	5
Supraordinate-Subordinate Relationships	NA	8	8	8	NA	5	5	5
Principles	NA	20	20	20	NA	10	10	10
Problem Solving	NA	10	10	10	NA	10	10	10
Total Battery	55	81	81	81	37	55	55	55

NA - Not appropriate for these grade groups.

presented to the child. After looking at the drawing for five seconds, the child is asked to turn to the next page of the answer booklet and find the drawing that looks exactly the same among four or seven plants. The correct choice has the same spatial orientation as on the preceding page. All instructions for this subtest are given orally and no written instructions appear.

The plants used vary systematically with respect to woody vs. non-woody stem and perennial vs. non-perennial (plant type), branching pattern and time of leaf fall (tree type), broad leaves vs. needles and flowers vs. cones (leaf/fruit type), single vs. multi-stemmed (stem type), and small-scale vs. large-scale drawing (size). The labels enclosed in parentheses were created for use in this manual in order to describe more easily the test materials. They are explained below. The ninth attribute on which the plants differ is shape. No two plants of the same shape are ever employed in the same item in any subscale. By varying the number of plants serving as alternatives and the number of attributes on which the incorrect alternatives differ from the correct choice, items of varying difficulties are obtained. The placement of the correct choice among the distractors is varied randomly across the eight items.

Two plant types, two tree types, two leaf/fruit types, two stem types, and two sizes are used. The plant types used are herb and tree. The tree types used are coniferous and deciduous. A third designation of non-tree is used for the herbs. The leaf/fruit types are broad leaf/flower and needle/cone. The stem types used are single stemmed and multiple stemmed. Each drawing may appear in two different sizes, designated small and large. The sides of the small figures are about 3.3 centimeters in length, and the sides of the large figures are about 4.5 centimeters. Table 2 presents

the plant descriptions used in each item in the concrete level subtest, together with their attributes and the number of attributes distinquishing the distractors from the target. The five-letter descriptors indicate the plant type, tree type, leaf/fruit type, stem type and size of each plant, in that order, using these abbreviations:

Plant Type	Tree Type	Leaf Type	Stem Type	Size
H Herb	N Non-tree	B Broadleaf/flower	S Single stem	S Small
T Tree	C Coniferous	N Needle/cone	M Multiple stems	L Large

Figures of the same description are used in the identity level, classificatory level and supraordinate-subordinate subtests, and the same sets of abbreviations will be used in referring to them.

TABLE 2

DESCRIPTION OF PLANTS EMPLOYED IN THE CONCRETE LEVEL SUBTEST

Item	Number of Distractors	Number of Attributes on which Distractors Differ from Target	Correct Choice	Other Plants Serving as Distractors
1	3	8 or 9	TCNSL	HNBML, HNBMS, HNBMS
2	6	6 or 7	TDBSS	HNBMS, HNBML, HNBMS, HNBML, HNBML, HNBML
3	6	5, 6, 7, or 8	TCNSS	HNBSS, TDBSS, TDBSS, TDBSL, TDBSS, HNBSL
4	3	5 or 6	TDBSL	TCNSL, HNBSS, TCNSL
5	3	1 or 5	TCNSL	TDBSL, TDBSL, TCNSL
6	6	1 or 5	TDBSS	TDBSS, TCNSS, TDBSS, TDBSS, TDBSS, TDBSS
7	6	1	TCNSS	TCNSS, TCNSS, TCNSS, TCNSS, TCNSS, TCNSS
8	3	1	TDBSL	TDBSL, TDBSL, TDBSL

Identity Level Subtest

This eight-item subtest is designed to assess whether a child has attained the concept tree at the identity level. In this subtest, the task and stimulus materials are like those employed at the concrete level. However, the correct choice on the second page of each item is rotated so that it has a different spatial orientation than on the preceding page. The distractors presented with the correct choice also appear in various orientations so that the correct choice is not conspicuous due to its irregular orientation. All instructions are given orally and no written instructions appear.

As in the concrete level subtest, the plants used vary systematically with respect to the nine attributes mentioned earlier, and the eight items are of differing difficulty due to varying numbers of distractors and varying degrees of similarity between the distractors and the correct choices. The order in which the distractors are presented and the description of the figures used are identical to those provided in the concrete level subtest described above. The placement of the correct choice among the distractors is varied randomly across the eight items. A description of the plants used, their attributes, and the number of attributes distinguishing the distractors from the target for each item of the identity level subtest is shown in Table 3 with the five-letter abbreviations given above. The table also shows the approximate rotations of each figure in degrees counterclockwise from an upright orientation. The target figure presented on the first page of each item is always a tree in an upright position.

Classificatory Level Subtest

This eight-item subtest is designed to assess whether a child has attained the concept tree at the classificatory level. In the first two

TABLE 3

DESCRIPTION OF PLANTS IN THE IDENTITY LEVEL SUBTEST, AND THEIR APPROXIMATE DEGREES OF ROTATION

Item	Number of Distractors	Number of Attributes on which Distractors Differ from Target	Correct Choice*	Other Plants Serving as Distractors
1	6	6 or 7	TDBSS (315°)	HNBMS (30°), HNBML (315°), HNBMS (315°), HNBML (30°), HNBML (315°), HNBML (315°)
2	3	8 or 9	TCNSL (45°)	HNBML (20°), HNBMS (45°), HNBMS (315°)
3	3	5 or 6	TDBSL (45°)	TCNSL (315°), HNBSS (90°), TCNSL (270°)
4	6	5, 6, 7, or 8	TCNSS (90°)	HNBSS (315°), TDBSS (270°), TDBSS (90°), TDBSL (45°), TDBSS (45°), HNBSL (270°)
5	6	1 or 5	TDBSS (180°)	TDBSS (180°), TCNSS (90°), TDBSS (180°), TDBSS (270°), TDBSS (90°), TDBSS (180°)
6	3	1 or 5	TCNSL (180°)	TDBSL (270°), TDBSL (90°), TCNSL (180°)
7	3	1	TDBSL (180°)	TDBSL (135°), TDBSL (270°), TDBSL (180°)
8	6	1	TCNSS (180°)	TCNSS (180°), TCNSS (215°), TCNSS (180°), TCNSS (90°), TCNSS (135°), TCNSS (270°)

*On the first page of each item, the correct choice is shown in a position corresponding to 0° rotation. The rotation as given above for each correct choice is for its representation among the other alternatives on the second page of the item.

items a tree is presented on the left side of the page, and the child is asked to mark the plant on the right which has the same kind of stem as the drawing on the left. In the remaining six items, the child is asked to mark all the drawings of plants which have woody stems. There is no example presented on the left side of the page, and the labels "tree" and "plant" are not used. Item 1 shows four plants including one tree on the right side of the page; item 2, seven plants including one tree; item 3, five plants including two trees; item 4, ten plants including four trees, item 5, five plants including two trees; item 6, ten plants including four trees; item 7, five plants including two trees; and item 8, ten plants including four trees. Each plant differs from the others with respect to at least one of the nine attributes listed above. By varying stem type as well as plant type, items of various difficulties are obtained. The trees are randomly interspersed with the other plants. Instructions are read aloud, but written instructions also appear in the test booklet for each item.

Specifications of the plants presented are identical to those of the concrete level subtest. Table 4 presents the attributes of the plants used in each item, using the same five-letter abbreviations as above. All figures are presented in an upright position (no rotation).

Formal Level Subtests

To determine if a concept has been attained at the formal level, three subtests are required: evaluating and defining, naming, and discriminating attributes.

Evaluating and Defining Subtest. This eleven-item multiple-choice subscale is designed to assess a child's ability to define the concept tree and to

TABLE 4

ATTRIBUTES OF PLANTS EMPLOYED IN THE CLASSIFICATORY LEVEL SUBTEST

Item	Example Plant	Tree(s)	Other Plants
1	TCHSL	TCNSL	HNBMS, HNBML, HNBMS
2	TDBSS	TDBSS	HNBMS, HNBML, HNBML, HNBML, HNBML, HNBMS
3	*	TDESS, TCNSS	HNBMS, HNBMS, HNBMS
4	*	TDBSS, TCNSS, TCNSS, TDBSS	HNBMS, HNBMS, HNBMS, HNBMS, HNBMS, HNBMS
5	*	TDBSS, TCNSS	HNBMS, HNBSS, HNBSS
6	*	TCNSS, TDBSS, TCNSS, TDBSS	HNBSS, HNBSS, HNBMS, HNBMS, HNBSS, HNBSS
7	*	TDBSS, TCNSS	HNBSS, HNBSS, HNBSS
8	*	TCNSS, TDBSS, TCNSS, TDBSS	HNBSS, HNBSS, HNBSS, HNBSS, HNBSS, HNBSS

*No example plant was employed in items 3 through 8.

evaluate instances as belonging or not belonging to the set "tree" based on the presence or absence of the defining attributes. The first six items present a figure drawing of a tree on the left-hand side of the page, labeled either "Thing X" or "Plant X." On the right-hand side of the page are three other figure drawings. The child is asked in what way "X" is different from all the other drawings. Five alternatives are presented for each item. The first four are statements of the form "Only Thing X _____" or "Only Plant X _____." The seventh, eighth, ninth and tenth items each present one deciduous and one coniferous tree on the left side of the page, together labeled "Group X." Two drawings not of trees on the right side of the page

are labeled "Group Y." The child is asked to indicate in what way the things in Group X are different from the things in Group Y. The fifth alternative for each item is "I don't know." The correct alternative is always one of the ten defining attributes, as presented in Table 5. The eleventh item in this subtest determines whether a child can recognize a definition of the concept tree which is acceptable to content experts. The child is asked to choose the correct definition of the concept from among five alternatives, including "I don't know." Instructions are read aloud. The test question and alternatives appear in the test booklet and are also read aloud. For the primary form of the test, Item 9 is not administered.

TABLE 5

DEFINING ATTRIBUTES BEING TESTED
BY EACH OF THE FIRST TEN ITEMS
OF THE EVALUATING AND DEFINING SUBTEST

Item	Defining Attribute
1	has roots
2	has leaves
3	has seeds
4	has single main stem
5	has woody stem
6	is perennial
7	has broad or needle leaves
8	bears flowers or cones
9	has branches which extend in an alternating, opposite or whorled pattern
10	has leaves which fall at end of growing season or leaves which may fall at any time throughout the season

Naming Subtest. This fourteen-item multiple-choice subtest is designed to assess a child's ability to label the societally-accepted attributes of the concept tree. Two types of items are used in this subtest. Two items present a drawing and ask the child to choose the answer which best describes or labels a particular portion of the drawing indicated by an arrow. The remaining twelve items each present two groups of drawings and the child must choose the label which best fits all the drawings in the first group but does not fit all the drawings in the second. All the items have five alternative choices, including "I don't know." Instructions are read aloud. The test question and alternatives tested by each item appear in Table 6. For the primary form of the test, items 8, 9, and 10 are not administered.

TABLE 6

NAMES OF ATTRIBUTES TESTED BY
EACH ITEM OF THE NAMING SUBTEST

Item	Attribute Label
1	green plant
2	tree
3	seed
4	root
5	stem
6	woody stem
7	leaf
8	perennial
9	deciduous tree
10	coniferous evergreen tree
11	broad leaf
12	needle
13	flower
14	cone

Discriminating Attributes Subtest. This ten-item subtest is designed to assess a child's ability to discriminate the societally-accepted attributes of the concept tree. In each item, four figures are presented and the child is asked to indicate the drawing which is different from the other three or to indicate the figure which has some particular property. In each case the correct alternative is the only drawing which possesses some defining attribute of the concept tree. The position of the correct alternative is varied randomly across the ten items. The defining attributes assessed by each item are presented in Table 7. Instructions are read aloud and also appear in the test booklet with each item.

TABLE 7

DEFINING ATTRIBUTES BEING TESTED BY EACH ITEM OF THE DISCRIMINATING ATTRIBUTES SUBTEST

Item	Attribute Distinguishing Correct Choice
1	roots vs. no roots
2	leaves vs. no leaves
3	seeds vs. no seeds
4	single-stemmed vs. multi-stemmed
5	woody vs. nonwoody
6	broad vs. needle leaves
7	flowers vs. cones
8	perennial vs. annual
9	branches extend in an alternating or opposite pattern vs. branches extend in a whorled pattern
10	leaves fall at end of growing season vs. leaves may fall at any time throughout the season

Supraordinate-Subordinate Relations Subtest

This eight-item multiple-choice subtest is designed to assess a child's ability to relate the concept tree to supraordinate, subordinate, and coordinate concepts. The child's understanding of four types of relations is assessed,

with two items for each type. In each item six plants are presented and a question is asked concerning the relationship of various subsets. The description of the plant attributes employed is the same as for the concrete level subtest. Statements of the four relations tested are given in Table 8, as are lists of all the plants presented for each item, and lists of those plants which are examples of the supraordinate, subordinate and/or coordinate classes to be related for each item. Examples of the plant classes referred to in the items are "trees," "evergreens," "herbs," etc. The child must select the correct answer to the test question from among four alternatives, including "I don't know." Instructions are read aloud. The test questions and alternatives appear in the test booklet and are also read aloud.

Principles Subtest

This twenty-item multiple-choice subtest is designed to assess whether a child understands various valid relationships among the properties of the concept tree. These relationships are stated as ten principles, each of which is tested both with and without illustration. In both cases an incomplete statement of a valid relationship between various properties of the concept is presented. The child must complete the statement by selecting the correct alternative from among five phrases, including "I don't know." Instructions are read aloud. The test questions and alternatives appear in the test booklet and are also read aloud. The principle tested in each item is listed in Table 9a, which also indicates whether or not an illustration is used with each item.

Problem-Solving Subtest

This ten-item multiple-choice subtest is designed to assess a child's ability to apply knowledge of the concept tree in a particular problem-solving

TABLE 8

RELATIONS TESTED AND CLASSES OF PLANTS EMPLOYED
IN THE SUPRAORDINATE-SUBORDINATE RELATIONS SUBTEST

Item	Type of relationship*	Figures Presented	Type of first class(es) involved in statement of relation	Figures in first class(es)	Type of second class involved in statement of relation	Figures in second class
1		TDBSS, HNBMS TCNSS, HNBMS, HNBMS, TDBSS	Supraordinate	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS	Subordinate	TDBSS, TCNSS, TDBSS
	II	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS	Subordinate	TCNSS, TCNSS, TCNSS	Supraordinate	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS
3	III	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS	Subordinate Subordinate	TDBSS, TCNSS, TDBSS HNBMS, HNBMS, HNBMS	Supraordinate	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS
4	IV	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS	Coordinate	TCNSS, TCNSS, TCNSS	Coordinate	TDBSS, TDBSS, TDBSS
5	I	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS	Supraordinate	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS	Subordinate	TCNSS, TCNSS, TCNSS
6	II	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS	Subordinate	TDBSS, TCNSS, TDBSS	Supraordinate	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS
7	III	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS	Subordinate Subordinate	TCNSS, TCNSS, TCNSS TDBSS, TDBSS	Supraordinate	TCNSS, TDBSS, TCNSS, TCNSS, TDBSS, TDBSS
8	IV	TDBSS, HNBMS, TCNSS, HNBMS, HNBMS, TDBSS	Coordinate	HNBMS, HNBMS, HNBMS	Coordinate	TDBSS, TCNSS, TDBSS

*The four relationships are as follows:

I. Some but not all members of a supraordinate class belong to a given subclass.
II. All members of a subclass are also members of a higher class.
III. The sum of the members of the subclasses equals the sum of the members of the supraordinate class.
IV. The members of one coordinate class are not members of another coordinate class.

TABLE 9

PRINCIPLES ASSESSED AND USE OF ILLUSTRATIONS
IN THE PRINCIPLES AND PROBLEM-SOLVING SUBTESTS

a. Principles Subtest

Item	Principle*	Format
1	I	with illustration
2	II	with illustration
3	III	with illustration
4	IV	with illustration
5	V	with illustration
6	VI	with illustration
7	VII	with illustration
8	VIII	with illustration
9	IX	with illustration
10	X	with illustration
11	I	without illustration
12	II	without illustration
13	III	without illustration
14	IV	without illustration
15	V	without illustration
16	VI	without illustration
17	VII	without illustration
18	VIII	without illustration
19	IX	without illustration
20	X	without illustration

b. Problem Solving Subtest

Item	Principle*	Format
1	I	with illustration
2	II	with illustration
3	III	with illustration
4	IV	with illustration
5	V	with illustration
6	VI	with illustration
7	VII	with illustration
8	VIII	with illustration
9	IX	with illustration
10	X	with illustration

*The ten principles are as follows:

I. The water and minerals that a tree needs to grow and to make food are collected by its roots.

II. Water, minerals, and organic materials are transported by the tree's trunk.

(continued on next page)

TABLE 9 (cont.)

III.	The food that a tree uses is usually produced by its leaves.
IV.	The seeds of a tree are formed from special cells in the tree's flowers.
V.	New trees develop from seeds.
VI.	Green plants use something released by animals, carbon dioxide.
VII.	The decay of animal waste products supplies plants with some of their minerals.
VIII.	Animals that eat only plants depend directly upon plants as a source of food. Animals that eat only other animals depend indirectly upon plants as a source of food.
IX.	All animals depend upon oxygen in the air. The major source of this oxygen is green plants.
X.	To grow and produce food a tree requires air, light, water, and minerals.

situation. For each item a drawing involving at least one tree or other plant is presented and the child is asked to solve a problem requiring the application of one of the ten principles mentioned above. The child must select the correct alternative from five choices, including "I don't know." The principle required for each item is presented in Table 9b. Instructions are read aloud. Test questions and alternatives appear in the test booklet and are also read aloud.

Additional Information for the Concept "Tree"

Information regarding the concept analysis of tree is available in the document by Klausmeier, Katzenmeyer, and Sipple (1973). This information includes definition of the concept; defining relevant and irrelevant attributes; examples and nonexamples of the concept used to assess the concrete, identity, classificatory, and/or formal levels and, in supraordinate-subordinate relations, principles, and/or problem-solving; taxonomy of concepts related to tree; and principles related to the concept. The source also gives a description of the content of each item in terms of the number and nature of the nonexamples used in the conrete and identity

subtests, descriptions of the relationships being assessed in the supra-ordinate-subordinate relationships subtest, the attributes tested in the discriminating attributes subtest, principles being tested in the principles and problem-solving subtests, and labels tested in the naming subtest.

DEVELOPMENT OF THE CONCEPTUAL LEARNING AND DEVELOPMENT ASSESSMENT SERIES IV: TREE

Guidelines Used in Test Development

At the beginning of the test development activity the following guidelines were established for test construction and selection of a concept to be assessed. Test materials and instructions were to be appropriate for use with children from preschool age through high school, and the test was to be group administered. It was necessary to choose a concept which could be presented in a paper-and-pencil format, which lent itself to definition in terms of defining attributes, and which was found in typical school curricula. The concept to be assessed had to be part of a taxonomy of related concepts, so that cognizing supraordinate and subordinate relationships could be tested; it also had to be usable in cognizing principles and in problem solving.

The concept tree was chosen to satisfy these guidelines for the curriculum area of science. Three other batteries were constructed to assess concepts in other curriculum areas.

A second set of guidelines was used in developing the directions for the test administration and item formats. The purpose of these guidelines was to ensure that valid responses could be obtained from children of all ages. First, "practice" questions would be offered. Second,

specific repetitions of instructions or questions would be prescribed for use with younger children to ensure that they fully grasped the nature of the task. Third, all items would be read aloud by the test administrator since reading ability was not the specific measurement objective. Fourth, attractive item formats would be used to engage the interest of the children. Fifth, all stimulus and response materials, such as in the classificatory items, would be arranged in a left-to-right flow. Sixth, items and pages would be designed so that children could easily keep their places.

Writing Items

Items were written according to specifications provided by the concept analyses and the guidelines reviewed earlier. Item writing was done by scholars at the Wisonsin Research and Development Center for Cognitive Learning who were knowledgeable in the area of conceptual learning and development and use of the CLD model. Guidance for item writing was provided by a measurement specialist who reviewed and edited all test items.

Review of Test Battery Content by Specialists

The test battery was reviewed for content accuracy by a content specialist in the area of science. Any inaccuracies in items were corrected at that time.

Tryout of Items

After the reviewing and editing were completed, the items and test directions were given an empirical tryout in fall of 1973 using a group of students in each of grades 1, 4, 7, and 10. Results of the tryout provided information regarding the clarity of instructions and illustrations, comprehensibility of test questions and alternatives, item difficulties, and amount of time needed to administer the battery. Finally, the results were examined to see if the younger children were biased toward selecting particular answer positions in the test booklet. Children selected for participation in the tryout included an equal number of boys and girls in the categories of high, medium, and low scholastic achievers in order to ensure that information concerning clarity of directions and estimates of time needed to administer the test would be generalizable to the entire school populations. As a result of the tryout, items and test instructions were further revised and became the final edition of the battery. Test administrations were done by the same trained personnel from the Wisconsin Research and Development Center for Cognitive Learning.

Development of Final Edition

Production of Final Test Materials. A number of factors were considered in constructing the battery booklets to increase standardization of administration. The points incorporated in the final battery ensure that the children perform to their best advantage. First, instructions specific to each item were read aloud and also appear in the test booklet, reducing the influence of reading ability on test scores. Second, the "STOP" instruction is prominently placed at the end of each item or bottom of each page as in the concrete and identity subtests. Third,

readability of the print is enhanced by use of a primary typewriter and sufficient spacing between items to eliminate confusion. Fourth, attractive item formats would be used to engage the interest of the children. Fifth, all stimulus and response materials would be arranged in a left-to-right flow. Sixth, items and paper would be designed so that children could easily keep their places.

The test is produced in four booklets and children mark their answers directly on the test booklets.

Writing Test Administration Manuals. The general instructions were prepared to increase the uniformity with which the test is administered. Procedures and materials to be used in the testing program are clearly outlined in Development of Conceptual Learning and Development Assessment Series IV: Tree (Klausmeier, Marliave, Katzenmeyer, & Sipple, 1974).

Instructions for administering specific subtests were developed on the basis of information gathered from the tryout of items on a small sample of children, criticisms and suggestions of test specialists, and suggestions of personnel who administered the test. The main criteria for these directions were clarity and usability. The test administration manual, found in the document Development of Conceptual Learning and Development Assessment Series IV: Tree (Klausmeier, Marliave, Katzenmeyer, & Sipple, 1974), was provided for the final edition. One advantage of the manual is the inclusion of the text printed in the children's test booklets. This feature reduces the number of booklets that have to be manipulated during test administration.

Computerized Analyses of Test Results. All information collected during the process of test development was prepared for electronic data processing.

Personnel from the Wisconsin Research and Development Center for Cognitive Learning first transferred each child's responses from a test booklet to an answer sheet, and then keypunched these responses on computer cards. A computer program was used to score the data and generate records which were used in subsequent analyses.

Summary

This section of the technical manual has emphasized the steps taken at each point in the development of the test battery. From the formulation of the theoretical framework and rationale, to the item writing and editing, through the tryout and preliminary edition, steps were taken to develop a final version of the instrument that would measure the level of conceptual attainment and usage of the concept tree.

II
STANDARDIZATION

The standardization of the Conceptual Learning and Development Assessment Series IV: Tree was designed to provide information about the test and its appropriateness for use with populations of normal children across a span of several grade groupings.

DESCRIPTION OF THE STANDARDIZATION SAMPLE

The standarization testing was conducted in winter of 1974 in Beloit, Wisconsin. Beloit's child and adult populations are representative of many small manufacturing-industrial communities in the Midwest. In 1972 the Beloit population was 35,729, including a black population of 2,606 (7 percent of the total population), and 17,255 persons (48 percent of the total) under 25 years of age. The economic level of the community is somewhat higher than the average for Midwest industrial communities: the 1970 average income per household was $9,460.00 and the median home value was $18,000.00 (Hooper & Klausmeier, 1973).

In the Beloit public school system there are 14 elementary schools, 3 junior high schools, and 1 senior high school. Total enrollment in these schools at the time of the standardization was approximately 10,000 students. Schools in which children were tested were selected in accord with the representative socioeconomic, ethnic, and general demographic classifications found in the city of Beloit (Hooper & Klausmeier, 1973).

Stratification variables used in selecting the population within each school were grade group and sex. Children from grades 1, 4, 7, and 10 were tested with an approximately equal number of boys and girls from each grade. The size, mean age, and range of age of the standardization sample for each grade group are presented in Table 10.

In the first year of the study, intact classrooms were randomly selected from among the schools chosen to represent the range of demographic characteristics discussed earlier. These children also served as the standardization sample for each of the other three batteries developed in the Conceptual Learning and Development Assessment Series.

TABLE 10

TOTAL NUMBER OF CHILDREN, MEAN AGE, AND AGE RANGE AT EACH GRADE GROUP IN THE STANDARDIZATION SAMPLE

Grade Group	Number		Mean Age (in years and months)	Age Range (in years and months)
1	Total	83	6 - 9	6 - 2 to 7 - 3
	Boys	41	6 - 9	6 - 2 to 7 - 3
	Girls	42	6 - 9	6 - 3 to 7 - 3
4	Total	93	9 - 9	9 - 2 to 10 - 7
	Boys	46	9 - 9	9 - 2 to 10 - 6
	Girls	47	9 - 9	9 - 2 to 10 - 7
7	Total	91	12 - 9	12 - 1 to 13 - 7
	Boys	44	12 - 9	12 - 2 to 13 - 7
	Girls	47	12 - 8	12 - 1 to 13 - 4
10	Total	87	15 - 8	15 - 1 to 16 - 6
	Boys	43	15 - 8	15 - 2 to 16 - 6
	Girls	44	15 - 7	15 - 1 to 16 - 4

ADMINISTRATION OF THE TEST TO THE STANDARDIZATION SAMPLE

The battery was administered to the standardization sample according to the instructions specified in the Development of Conceptual Learning and Development Assessment Series IV: Tree (Klausmeier, Marliave, Katzenmeyer, & Sipple, 1974). Tests were administered by trained personnel from the Wisconsin Research and Development Center for Cognitive Learning. For grades 4, 7, and 10 the battery was administered to classroom groups of 20 to 30 children, while for the first grade it was administered to smaller groups of five to seven children. The entire battery was read to children regardless of grade level. Children marked their answers directly on the test pages; a separate answer sheet was not used.

MEANS AND STANDARD DEVIATIONS FROM THE STANDARDIZATION SAMPLE

Table 11 gives summary data for the raw scores resulting from the standardization testing. Means and standard deviations are given for each grade grouping on each subtest administered as well as on a combined formal level score, a total levels score, and a total uses score. Appendix A contains the same summary data for each sex for each grade group.

As mentioned in Chapter 1, it is not necessary or desirable to administer all items or subtests to each grade group. Since it is assumed, based on information collected during the tryout of the battery, that children in the higher grade groups would respond correctly to all concrete level and identity level items, those subtests were administered to grade groups 1 and 4 only.[1] On the other hand, primary-aged children respond incorrectly to most items in the three concept usage subscales: supraordinate-subordinate relations,

[1] Although summary data on the concrete level and identity level subtests are presented for the grade 4 group, examination of the data suggests that the subtests are too easy for use with grade 4 as well (see Table 1, Chapter 1).

TABLE 11

MEANS AND STANDARD DEVIATIONS OF RAW SCORES ON EACH SUBTEST AND ON A COMBINED FORMAL SCORE, TOTAL LEVELS SCORE, AND TOTAL USES SCORE, BY GRADE GROUP FOR THE STANDARDIZATION SAMPLE

Subtest	Grade Group			
	1(n=83)	4(n=93)	7(n=91)	10(n=87)
Concrete (8 items)				
Mean	7.72	7.87	NA[a]	NA[a]
SD	.53	.37		
Identity (8 items)				
Mean	7.58	7.77	NA[a]	NA[a]
SD	.63	.45		
Classificatory (8 items)				
Mean	6.16	7.39	7.25	7.69
SD	2.19	1.39	1.70	.93
Evaluating & Defining (11 items)				
Mean	1.60	5.81	7.63	9.01
SD	1.68	2.55	2.82	1.95
Discriminating Attributes (10 items)				
Mean	8.99	9.22	9.43	9.59
SD	1.44	.90	.79	.58
Naming (14 items)				
Mean	4.08	7.30	9.49	11.40
SD	2.36	2.80	2.79	2.10
Combined Formal (35 items)				
Mean	14.67	22.32	26.55	30.00
SD	4.05	4.94	5.45	3.60
Total Levels (59 items)				
Mean	36.13	45.35	49.80	53.69
SD	5.25	5.47	6.63	4.03
Supraordinate-Subordinate Relationships (8 items)				
Mean	NA[b]	4.34	4.95	5.93
SD		1.30	1.54	1.57
Principles (20 items)				
Mean	NA[b]	8.66	11.55	15.56
SD		3.56	3.95	3.92

TABLE 11 (cont.)

Subtest	Grade Group			
	1(n=83)	4(n=93)	7(n=91)	10(n=87)
Problem Solving (10 items)				
Mean	NA[b]	3.08	4.20	5.56
SD		1.62	1.96	2.20
Total Uses (38 items)				
Mean	NA[b]	16.08	20.69	27.06
SD		4.54	6.45	6.72

[a]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group. All children in this grade group received full credit for this subtest in the computation of the Total Levels Score.

[b]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too difficult for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group.

principles, and problem-solving. Therefore, those three subtests were not administered to grade group 1 of the standardization sample. All other subtests were administered to each grade group.

III

STATISTICAL PROPERTIES

In reporting statistical data, three summary scores have been employed. The three subtests which are part of the formal level have been included in the combined formal level score which is equal to their sum. Inasmuch as the scores on these three subtests are always used in conjunction to assess attainment at the formal level, information on their individual properties is of lesser interest. A total levels score equal to the sum of the concrete level, identity level, classificatory level, and combined formal scores and a total uses score equal to the sum of the supraordinate-subordinate relationships, principles, and problem solving subtest scores are also presented. These two total scores provide summative indices of the two major aspects of the CLD model, namely conceptual attainment and conceptual utilization and extension.

RELIABILITY

Internal consistency for this battery was determined by the use of Hoyt's analysis of variance procedure, which is algebraically equivalent to Kuder Richardson's formula 20 and Cronbach's coefficient alpha. Internal consistency is of more interest than test-retest reliability in this battery, given that children's attainment of concepts is not expected to remain stable over time. Table 12 presents the Hoyt reliability coefficients and standard errors of measurement of the individual subtests and of the combined formal level score, total levels score, and total uses score within each grade group and across the four grade groups.

TABLE 12

HOYT RELIABILITY COEFFICIENTS AND STANDARD ERRORS OF MEASUREMENT ON EACH SUBTEST AND ON A COMBINED FORMAL SCORE, TOTAL LEVELS SCORE, AND TOTAL USES SCORE, FOR GRADE GROUP AND ACROSS THE FOUR GROUPS FOR THE STANDARDIZATION SAMPLE

Subtest	Grade Group				
	1 (n=83)	4 (n=93)	7 (n=91)	10 (n=87)	Combined Grades (n-354)
Concrete (8 items)					
Reliability	.08	NR[a]	NA[b]	NA[b]	.16
SE_M	.47				.29
Identity (8 items)					
Reliability	.06	NR[a]	NA[b]	NA[b]	.15
SE_M	.57				.36
Classificatory (8 items)					
Reliability	.81	.81	.88	.76	.84
SE_M	.89	.57	.55	.43	.63
Combined Formal (35 items)					
Reliability	.76	.78	.86	.78	.91
SE_M	1.96	2.27	2.00	1.68	2.10
Total Levels (59 items)					
Reliability	.78	.79	.89	.80	.92
SE_M	2.42	2.50	2.18	1.79	2.39
Supraordinate-Subordinate Relationships (8 items)					
Reliability	NA[c]	.28	.49	.62	.72[d]
SE_M		1.03	1.03	.90	1.01
Principles (20 items)					
Reliability	NA[c]	.70	.77	.83	.93[d]
SE_M		1.89	1.84	1.57	1.62
Problem Solving (10 items)					
Reliability	NA[c]	.38	.51	.61	.67[d]
SE_M		1.21	1.30	1.30	1.24
Total Uses (38 items)					
Reliability	NA[c]	.67	.84	.88	.94[d]
SE_M		2.58	2.55	2.31	2.38

TABLE 12 (Cont.)

[a]NR (Not Reported). Upon examination of the results of the standardized testing, as indicated by the means and standard deviations reported in Table 11, this subtest was found to be too easy for use with this grade group (see Table 1, Chapter 1). Accordingly, reliability information would be meaningless and is not reported.

[b]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group. All children in this grade group received full credit for this subtest in the computation of the total levels statistic and in the computation of the combined grades concrete and identity subtest statistics.

[c]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too difficult for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group.

[d]Primary aged children who did not receive this subtest were treated as earning total scores of zero in computing test statistics across grades.

Examination of Table 12 reveals that of the 35 Hoyt reliabilities reported over 60 percent of them are .70 or better. Inspection of Table 11 containing means and standard deviations indicates that many of the lower reliabilities were obtained in cases where subtest means were over 90 percent of the total possible subtest score and standard deviations were very small. Means in this range and low standard deviations indicate an attenuation of the range of obtained scores which preclude higher Hoyt reliabilities being obtained. Although these subtests do not discriminate among the majority of the children in these grade groups, they provide valuable information in that they identify children who may not have attained the corresponding level of conceptual development or facility in concept utilization. Other low reliabilities were obtained in cases where

the associated means and standard deviations were very low, again precluding higher Hoyt reliabilities being obtained. These subtests will nonetheless identify children who have attained higher levels of conceptual development or greater facility in concept utilization.

ITEM DIFFICULTIES (PERCENT OF CORRECT RESPONSE)

Item difficulties in the form of percent of correct response to each item by grade group and across the grade groups are included in Appendix B. Point biserial correlations of each item with the total test score across the four grade groupings are also presented.

The point biserial correlations were obtained by relating each of the items in the concrete level, identity level, classificatory level, and combined formal level subtests to the total levels score and each of the items in the supraordinate-subordinate relationships, principles, and problem-solving subtests to the total uses score.

The fact that a greater precent of children answer a test item correctly in higher grade groups than in lower grade groups provides some evidence for the validity of the item. In grade groups 7 and 10 it is more likely that children have received instruction in the concept tree than it is in grade groups 1 and 4. Thus it is expected that they would perform better than the children in the lower grade groups. The item difficulties reported in Appendix B support this expected pattern in almost all cases.

INTERCORRELATION OF THE TOTAL LEVELS SCORE WITH THE TOTAL USES SCORE

The intercorrelation of the total levels score with the total uses score is presented in Table 13 for each of the grade groupings and across

all the grade groups. The intercorrelation of the scores was not computable for grade group 1, since they did not receive any of the uses subtests. The range of correlations within each grade group is .47 to .80; the intercorrelation of the scores when all grade groups are combined is .84. These intercorrelations give support to the assumption that concept utilization is positively related to concept attainment.

TABLE 13

INTERCORRELATION OF THE TOTAL LEVELS SCORE AND THE TOTAL USES SCORE, BY GRADE GROUP AND ACROSS GRADE GROUPS FOR THE STANDARDIZATION SAMPLE

Grade Group	Correlation
1 (n = 83)	NA[a]
4 (n = 93)	.47
7 (n = 91)	.80
10 (n = 87)	.59
All Grade Groups (n = 354)	.84[b]

[a] NA (Not Administered). On the basis of test results obtained with the preliminary edition of the battery, all of the uses subtests were judged to be too difficult for use with first-grade children. Thus, when the final edition was administered these subtests were not included for this grade group.

[b] Primary-aged children who did not receive the uses subtests were treated as earning total scores of zero on total uses for the purposes of this correlation.

PATTERNS OF CONCEPT ATTAINMENT

One important use of the Conceptual Learning and Development Series IV: Tree is in the placement of individual children on the continum of conceptual development with respect to the concept tree. For some applications it is desirable to reduce this information to the single datum of the level at which the child is performing. To facilitate this placement, a scoring scheme has been developed to indicate mastery vs. nonmastery of each of the concrete level, identity level, classificatory level, and combined formal subtests. All items are given equal weight, and full attainment of a level is indicated by a score greater than or equal to a predefined criterion score on the corresponding subtest. These criteria are presented in Table 14.

TABLE 14

NUMBER OF ITEMS AND CRITERIA DEFINING FULL ATTAINMENT FOR EACH CONCEPT LEVEL

Subtest	Number of Items	Criteria for Full Attainment
Concrete	8	7 correct
Identity	8	7 correct
Classificatory	8	7 correct
Formal		
Evaluating and Defining	11	28 items correct or approximately 80% of combined formal items
Discriminating Attributes	10	
Naming	14	

Inasmuch as the test battery charts a child's passage through qualitatively different levels of conceptual attainment as additional cognitive operations are acquired, traditional indices of test performance suitable for use with norm-referenced measures are not entirely appropriate and may not adequately reflect the performance of the battery. Accordingly, in addition to Hoyt coefficients of reliability and traditional item statistics, a criterion-referenced scoring scheme is presented, and patterns of percent mastery across grade groups and across subtests assessing successive levels of conceptual attainment are also presented and discussed.

Table 15 presents the number and proportion of children within and across the four grade groups who mastered each of the four levels of concept attainment. According to the CLD model, the percentage of children passing each of the four successive levels should decrease within each grade group. Furthermore, for each of the four levels, the percentage of children passing should increase from the lower to the higher grade groups. Inspection of Table 15 reveals that only one exception to these predictions occurred, and that was a decrease of only 1 percent where an increase was predicted, from grade group 4 to grade group 7 for the classificatory level subtest. Overall, the proportion of the 354 children who passed the various levels was .99 concrete level, .98 identity level, .82 classificatory level, and .38 formal level. In the light of the theoretical predictions of the CLD model, these results support the validity of mastery decisions made on the basis of the test battery.

In addition to placing individual children at one of the four levels, these mastery decisions permit examination of the validity of the test battery in the light of the hierarchical nature of the model. Inasmuch

TABLE 15

NUMBER AND PROPORTION OF EACH GRADE GROUP THAT FULLY MASTERED EACH LEVEL OF ATTAINMENT

Grade	Concrete	Identity	Classificatory	Combined Formal
1st (n=83)				
Number	80	77	48	0
Proportion	.96	.93	.58	.00
4th (n=93)				
Number	92	92	81	13
Proportion	.99	.99	.87	.14
7th (n=91)				
Number	91	91	78	47
Proportion	1.00	1.00	.86	.52
10th (n=87)				
Number	87	87	84	74
Proportion	1.00	1.00	.97	.85
All Grades (n=354)				
Number	350	347	291	134
Proportion	.99	.98	.82	.38

as attainment of each level requires the presence of conceptual abilities characteristic of the preceding levels, the model predicts that no child should master any one of the four levels subtests unless he also masters all preceding levels subtests. It is hypothesized that each successive level of attainment requires the use of one or more new cognitive operations. Therefore, each subtest would be more difficult than the previous one. A given pattern of attainment as indicated by the four mastery decisions derived from the levels subtests may be represented by a string of four letters, each either "P" or "F," denoting mastery (Passing) or nonmastery (Failing) of the corresponding subtest. The leftmost letter in such a string represents the concrete level subtest; the second, identity level;

the third, classificatory; and the rightmost, combined formal. Thus, the pattern of attainment of a child who mastered the concrete level and identity level subtests and failed to master the classificatory level and combined formal subtests would be represented by the string "PPFF." On the children will attain one of the following 5 of 16 possible patterns: FFFF, PFFF, PPFF, PPPF, AND PPPP.

Table 16 shows the number and proportion of each grade group that attained the successive levels according to the five patterns and also the number and proportion of each grade group that were exceptions to the five patterns. Information regarding those who performed according to the predicted patterns is given in the top five rows; the exceptions are given in the lower rows. Of the 354 children, 346 or 98 percent performed according to the predicted patterns; only 2 percent or 8 children failed to conform to expected patterns.

The high percentage of children conforming to the predicted patterns supports the major proposition of the CLD model, that individuals attain concepts in a highly predictable pattern involving the four successive levels: concrete, identity, classificatory, and formal. The results also support the validity of the test battery as effectively charting the course of the development of the concept tree.

TABLE 16

NUMBER AND PROPORTION OF FOUR GRADE GROUPS CONFORMING AND NOT CONFORMING TO PREDICTED SEQUENCE OF ATTAINMENT

Pass-Fail Sequence	1st (n=83)	4th (n=93)	7th (n=91)	10th (n=87)	All Grades (n=354)
FFFF	1 .01	0 .00	0 .00	0 .00	1 .00
PFFF	4 .05	0 .00	0 .00	0 .00	4 .01
PPFF	29 .35	10 .11	12 .13	2 .02	53 .15
PPPF	46 .55	68 .73	32 .35	11 .13	157 .44
PPPP	0 .00	12 .13	46 .51	73 .84	131 .37
Subtotal Conforming	80 .96	90 .97	90 .99	86 .99	346 .98
FFFP	0 .00	0 .00	0 .00	0 .00	0 .00
FFPF	0 .00	0 .00	0 .00	0 .00	0 .00
FFPP	0 .00	0 .00	0 .00	0 .00	0 .00
FPFF	1 .01	1 .01	0 .00	0 .00	2 .01
FPFP	0 .00	0 .00	0 .00	0 .00	0 .00
FPPF	1 .01	0 .00	0 .00	0 .00	1 .00
FPPP	0 .00	0 .00	0 .00	0 .00	0 .00
PFFP	0 .00	0 .00	0 .00	0 .00	0 .00
PFPF	1 .01	1 .01	0 .00	0 .00	2 .01
PFPP	0 .00	0 .00	0 .00	0 .00	0 .00
PPFP	0 .00	1 .01	1 .01	1 .01	3 .01
Subtotal Not Conforming	3 .04	3 .03	1 .01	1 .01	8 .02

REFERENCES

Hooper, F. H., & Klausmeier, H. J. Description and rationale for a longitudinal assessment of children's cognitive development and concept learning. Working Paper No. 113. Madison: Wisconsin Research and Development Center for Cognitive Learning, 1973.

Klausmeier, H. J. Cognitive operations in concept learning. Educational Psychologist, 1971, 9(1), 1-7.

Klausmeier, H. J., Davis, J. K., Ramsay, J. G., Fredrick, W. C., & Davies, M. H. Concept learning and problem solving: A bibliography, 1950-1964. Technical Report No. 1. Madison: Wisconsin Research and Development Center for Cognitive Learning, 1965.

Klausmeier, H. J. Ghatala, E. S., & Frayer D. A. Levels of concept attainment and the related cognitive operations. Theoretical Paper No. 40. Madison: Wisconsin Research and Development Center for Cognitive Learning, 1972.

Klausmeier, H. J., Ghatala, E. S., & Frayer D. A. Conceptual Learning and Development: A Cognitive View. New York: Academic Press, 1974.

Klausmeier, H. J., Katzenmeyer, C. G., & Sipple, T. S. Analysis of tree. Mimeographed paper. Madison: Wisconsin Research and Development Center for Cognitive Learning, 1973.

Klausmeier, H. J., Marliave, R., Katzenmeyer, C. G., & Sipple, T. S. Development of conceptual learning and development assessment series IV: Tree. Technical Report No. 437. Madison: Wisconsin Research and Development Center for Cognitive Learning, 1974. Reprinted December 1977.

Kofsky, E. A scalogram study of classificatory development. Child Development, 1966, 37, 191-204.

APPENDIX A

DESCRIPTIVE SCALE STATISTICS
FOR THE TREE BATTERY

TABLE A-1

MEANS AND STANDARD DEVIATIONS OF RAW SCORES ON EACH SUBTEST AND ON A COMBINED FORMAL SCORE, TOTAL LEVELS SCORE, AND TOTAL USES SCORE, BY GRADE GROUP, FOR BOYS IN THE STANDARDIZATION SAMPLE

Subtest	Grade Group			
	1(n=41)	4(n=47)	7(n=44)	10(n=44)
Concrete (8 items)				
Mean	7.73	7.85	NA[a]	NA[a]
SD	.50	.42		
Identiy (8 items)				
Mean	7.66	7.81	NA[a]	NA[a]
SD	.57	.40		
Classificatory (8 items)				
Mean	6.15	7.32	7.14	7.52
SD	2.25	1.62	1.80	1.25
Evaluating & Defining (11 items)				
Mean	1.68	6.28	7.02	8.48
SD	1.89	2.45	3.21	2.25
Discriminating Attributes (10 items)				
Mean	8.93	9.21	9.[illegible]2	9.61
SD	1.56	.78	.96	.58
Naming (14 items)				
Mean	4.07	7.89	9.32	11.36
SD	2.40	2.78	3.17	2.49
Combined Formal (35 items)				
Mean	14.68	23.38	25.66	29.45
SD	4.10	4.73	6.34	4.41
Total Levels (59 items)				
Mean	36.22	46.24	48.80	52.88
SD	5.48	5.31	7.64	5.07
Supraordinate-Subordinate Relationships (8 items)				
Mean	NA[b]	4.70	4.73	6.11
SD		1.23	1.72	1.60
Principles (20 items)				
Mean	NA[b]	9.38	11.48	15.91
SD		3.54	4.56	3.99
Problem Solving (10 items)				
Mean	NA[b]	3.09	4.43	5.86
SD		1.53	1.97	2.37
Total Uses (38 items)				
Mean	NA[b]	17.17	20.64	27.89
SD		4.40	7.37	7.19

TABLE A-1 (Cont.)

[a]NA (Not Administered). On the basis of test results obtained in the tryout of the battery this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group. All children in this grade group received full credit for this subtest in the computation of the total levels score.

[b]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too difficult for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group.

TABLE A-2

MEANS AND STANDARD DEVIATIONS OF RAW SCORES ON EACH SUBTEST AND ON A COMBINED FORMAL SCORE, TOTAL LEVELS SCORE, AND TOTAL USES SCORE, BY GRADE GROUP, FOR GIRLS IN THE STANDARDIZATION SAMPLE

Subtest	Grade Group			
	1 (n=42)	4 (n=46)	7 (n=47)	10 (n=43)
Concrete (8 items)				
Mean	7.71	7.89	NA[a]	NA[a]
SD	.55	.31		
Identity (8 items)				
Mean	7.50	7.74	NA[a]	NA[a]
SD	.67	.49		
Classificatory (8 items)				
Mean	6.17	7.46	7.36	7.86
SD	2.15	1.13	1.62	.35
Evaluating & Defining (11 items)				
Mean	1.52	5.33	8.19	9.56
SD	1.47	2.58	2.29	1.42
Discriminating Attributes (10 items)				
Mean	9.05	9.22	9.53	9.56
SD	1.32	1.01	.58	.59
Naming (14 items)				
Mean	4.10	6.70	9.66	11.44
SD	2.36	2.73	2.41	1.65
Combined Formal (35 items)				
Mean	14.67	21.24	27.38	30.56
SD	4.04	4.97	4.38	2.44
Total Levels (59 items)				
Mean	36.05	44.49	50.74	54.48
SD	5.07	5.55	5.44	2.47
Supraordinate-Subordinate Relationships (8 items)				
Mean	NA[b]	3.98	5.15	5.74
SD		1.27	1.35	1.53
Principles (20 items)				
Mean	NA[b]	7.91	11.62	15.21
SD		3.46	3.32	3.86
Problem Solving (10 items)				
Mean	NA[b]	3.07	3.98	5.26
SD		1.72	1.95	1.99
Total Uses (38 items)				
Mean	NA[b]	14.96	20.74	26.21
SD		4.45	5.54	6.16

TABLE A-2 (Cont.)

[a]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group. All children in this grade group received full credit for this subtest in the computation of the total levels score.

[b]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too difficult for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group.

APPENDIX B

DESCRIPTIVE ITEM STATISTICS FOR THE TREE BATTERY

TABLE B-1

DIFFICULTIES OF EACH ITEM IN THE TOTAL LEVELS SCORE BY GRADE GROUP, AND DIFFICULTIES AND POINT BISERIAL CORRELATIONS FOR THE SAME ITEMS COMBINING GRADE GROUPS FOR THE STANDARDIZATION SAMPLE

Item	1(n = 83) Difficulty	4(n = 93) Difficulty	7(n = 91) Difficulty	10(n = 87) Difficulty	Combined Grades (n = 354) Difficulty	r
Concrete Subtest						
1	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
2	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
3	.99	NR[a]	NA[b]	NA[b]	1.00	.07
4	.99	NR[a]	NA[b]	NA[b]	1.00	.05
5	.99	NR[a]	NA[b]	NA[b]	.99	.08
6	.93	NR[a]	NA[b]	NA[b]	.97	.24
7	.88	NR[a]	NA[b]	NA[b]	.97	.20
8	.95	NR[a]	NA[b]	NA[b]	.98	.15
Identity Subtest						
9	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
10	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
11	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
12	1.00	NR[a]	NA[b]	NA[b]	1.00	.00
13	.84	NR[a]	NA[b]	NA[b]	.94	.22
14	.98	NR[a]	NA[b]	NA[b]	.99	.17
15	.90	NR[a]	NA[b]	NA[b]	.96	.21
16	.86	NR[a]	NA[b]	NA[b]	.94	.22
Classificatory Subtest						
17	.98	.98	.98	1.00	.97	.33
18	.80	.97	.97	1.00	.94	.38
19	.81	.94	.91	.95	.90	.44
20	.71	.89	.87	.95	.86	.45
21	.76	.91	.85	.90	.86	.35
22	.70	.86	.89	.97	.86	.50
23	.72	.91	.90	.95	.88	.46
24	.73	.92	.89	.97	.88	.46

TABLE B-1 (cont.)

Item	1(n = 83) Difficulty	(n = 93) Difficulty	7(n = 91) Difficulty	10(n = 87) Difficulty	Combined Grades (n = 354) Difficulty	r
Evaluating & Defining Subtest						
25	.22	.77	.86	.94	.71	.72
26	.30	.77	.82	.95	.72	.72
27	.23	.51	.87	.95	.64	.70
28	.10	.35	.55	.75	.44	.59
29	.07	.60	.82	.86	.60	.70
30	.13	.66	.77	.84	.61	.66
31	.11	.47	.75	.87	.56	.67
32	.20	.41	.66	.92	.55	.57
33	.04	.35	.36	.41	.30	.41
34	.11	.41	.47	.59	.40	.43
35	.10	.49	.69	.92	.56	.66
Discriminating Attributes Subtest						
36	.95	.98	1.00	1.00	.98	.18
37	.90	.97	.97	.98	.95	.28
38	.96	1.00	.99	1.00	.99	.21
39	.95	.99	.99	1.00	.98	.25
40	.89	.95	.97	.99	.95	.14
41	.92	.94	.98	.97	.95	.13
42	.96	.98	1.00	1.00	.99	.18
43	.67	.90	.90	.98	.87	.36
44	.89	.58	.65	.69	.70	-.05
45	.88	.94	.99	.99	.95	.27
Naming Subtest						
46	.17	.44	.69	.83	.54	.65
47	.45	.52	.76	.89	.65	.56
48	.63	.78	.89	.98	.82	.53
49	.71	.98	.95	.97	.90	.48
50	.45	.78	.82	.92	.75	.51
51	.17	.55	.71	.82	.57	.63
52	.24	.68	.90	.95	.70	.64
53	.00	.11	.15	.18	.11	.20
54	.00	.34	.47	.67	.38	.56
55	.00	.37	.54	.82	.44	.63
56	.05	.15	.24	.60	.26	.46
57	.34	.37	.73	.89	.58	.58
58	.55	.73	.87	.97	.78	.57
59	.34	.51	.77	.94	.64	.59

TABLE B-1 (cont.)

[a]NR (Not Reported). Upon examination of the results of the standardized testing, as indicated by the means and standard deviations reported in Table 11, this subtest was found to be too easy for use with this grade group (see Table 1, Chapter 1). Accordingly, item statistics would be meaningless and are not reported.

[b]NA (Not Administered). On the basis of test results obtained in the tryout of the battery, this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group. All children in this grade group received full credit for this subtest in the computation of the total levels statistic and in the computation of the combined grades concrete and identity subtest statistics.

TABLE B-2

DIFFICULTIES OF EACH ITEM IN THE TOTAL USES SCORE BY GRADE GROUP, AND DIFFICULTIES AND POINT BISERIAL CORRELATIONS FOR THE SAME ITEMS COMBINING GRADE GROUPS FOR THE STANDARDIZATION SAMPLE

Item	1 (n = 83) Difficulty	4 (n = 93) Difficulty	7 (n = 91) Difficulty	10 (n = 87) Difficulty	Combined Grades (n = 354) Difficulty[b]	r[b]
Supraordinate-Subordinate Relationships Subtest						
1	NA[a]	.98	.95	1.00	.87	.50
2	NA[a]	.73	.75	.80	.71	.33
3	NA[a]	.66	.74	.86	.59	.59
4	NA[a]	.06	.08	.24	.10	.35
5	NA[a]	.78	.84	.91	.72	.49
6	NA[a]	.43	.55	.79	.52	.48
7	NA[a]	.59	.68	.82	.53	.63
8	NA[a]	.11	.37	.51	.25	.55
Principles Subtest						
9	NA[a]	.73	.79	.91	.63	.70
10	NA[a]	.43	.54	.71	.43	.60
11	NA[a]	.18	.32	.59	.28	.53
12	NA[a]	.40	.46	.75	.41	.67
13	NA[a]	.73	.75	.76	.59	.59
14	NA[a]	.32	.56	.77	.42	.68
15	NA[a]	.32	.64	.87	.46	.67
16	NA[a]	.15	.30	.63	.27	.54
17	NA[a]	.39	.74	.84	.50	.72
18	NA[a]	.62	.84	.90	.60	.70
19	NA[a]	.73	.81	.94	.64	.74
20	NA[a]	.42	.49	.80	.44	.62
21	NA[a]	.19	.20	.60	.25	.54
22	NA[a]	.24	.34	.67	.31	.67
23	NA[a]	.69	.79	.89	.62	.67
24	NA[a]	.40	.70	.78	.48	.67
25	NA[a]	.34	.65	.83	.46	.68
26	NA[a]	.24	.29	.59	.28	.55
27	NA[a]	.45	.62	.85	.49	.70
28	NA[a]	.68	.74	.90	.59	.72

TABLE B-2 (cont.)

Problem Solving Subtest						
29	NA[a]	.35	.37	.49	.34	.34
30	NA[a]	.18	.32	.59	.30	.44
31	NA[a]	.28	.19	.29	.23	.19
32	NA[a]	.25	.37	.66	.36	.50
33	NA[a]	.80	.82	.79	.73	.31
34	NA[a]	.08	.27	.51	.23	.59
35	NA[a]	.16	.55	.75	.37	.68
36	NA[a]	.14	.18	.22	.15	.25
37	NA[a]	.57	.64	.68	.53	.45
38	NA[a]	.27	.48	.60	.40	.42

[a]NA (Not Administered). On the basis of test results obtained with the preliminary edition of the battery, this subtest was judged to be too easy for use with this grade group. Thus, when the final edition was administered this subtest was not included for this grade group.

[b]Primary aged children who did not receive the uses subtests were treated as answering all items incorrectly in the computation of item difficulties and biserial correlations combining grades.

Center Planning and Policy Committee

Richard A. Rossmiller
Wayne Otto
Center Co-directors

Wayne Otto
Area Chairperson
Studies in Reading, Language and Communication

Marvin J. Fruth
Area Chairperson
Studies of Implementation of Individualized Schooling

Herbert J. Klausmeier
Area Chairperson
Studies of Instructional Programming for the Individual Student

James M. Lipham
Area Chairperson
Studies of Administration and Organization for Instruction

Thomas A. Romberg
Area Chairperson
Studies in Mathematics and Evaluation of Practices in Individualized Schooling

Associated Faculty

Vernon L. Allen
Professor
Psychology

B. Dean Bowles
Professor
Educational Administration

Thomas P. Carpenter
Associate Professor
Curriculum and Instruction

W. Patrick Dickson
Assistant Professor
Child and Family Studies

Marvin J. Fruth
Professor
Educational Administration

John G. Harvey
Professor
Mathematics
Curriculum and Instruction

Frank H. Hooper
Professor
Child and Family Studies

Dale D. Johnson
Professor
Curriculum and Instruction

Herbert J. Klausmeier
V.A.C. Henmon Professor
Educational Psychology

Joseph T. Lawton
Assistant Professor
Child and Family Studies

Joel R. Levin
Professor
Educational Psychology

James M. Lipham
Professor
Educational Administration

Dominic W. Massaro
Professor
Psychology

Donald M. McIsaac
Professor
Educational Administration

Wayne R. Otto
Professor
Curriculum and Instruction

Penelope L. Peterson
Assistant Professor
Educational Psychology

Robert G. Petzold
Professor
Music
Curriculum and Instruction

Thomas S. Popkewitz
Associate Professor
Curriculum and Instruction

Gary G. Price
Assistant Professor
Curriculum and Instruction

Thomas A. Romberg
Professor
Curriculum and Instruction

Richard A. Rossmiller
Professor
Educational Administration

B. Robert Tabachnick
Professor
Curriculum and Instruction

J. Fred Weaver
Professor
Curriculum and Instruction

Gary G. Wehlage
Associate Professor
Curriculum and Instruction

977